

EPIDEMIOLOGY AND OUTCOME OF 2,590 BURNED PATIENTS IN NORTHWEST IRAN

ÉPIDÉMIOLOGIE ET ÉVOLUTION DE 2 590 BRÛLÉS DANS LE NORD-EST DE L'IRAN

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SUMMARY. Burns are calamities with considerable morbidity and mortality rates. We attempted to examine the epidemiology of burns in Zanjan city, in northwest Iran, by a systematic study of existing information. The medical files of 2,590 thermal burn patients treated in our hospital in Zanjan city, Iran, from December 2010 to November 2016 were studied. Patient information, including age, sex, burn degree, season, cause of burn, hospital stay and treatment results were analyzed. About 65% of the patients were male (n=1691). Most burns (92.8%) were less than 30% total body surface area. Mean age and hospital stay were 25.4 years old and 9.1 days, respectively. The most common causes of burn were hot liquids, gas explosion and fire, respectively. Except for self-immolation, which was more common among men, there was no significant relationship between cause of burn and the studied variables. The six-year mortality rate was 2.9%, and was more common in the years 2011 to 2013. In addition, distribution of causes of burn had a significant trend (variation). Fire burn had a decreasing trend and gas and chemical burn had increasing trends in this period. In northwest Iran the causes of burn changed over the six years. Chemical burns, gas explosion burns and burn mortality increased. Some of these results were due to economic and pharmaceutical sanctions in Iran. Because of Iran's industrial development, it is recommended that preventive measures for chemical, gas and electrical burns be conducted.

Keywords: epidemiology, burns, Iran, mortality, chemical burns

RÉSUMÉ. Les brûlures sont des accidents responsables d'une morbidité et d'une mortalité considérables. Nous avons réalisé une étude rétrospective sur dossiers afin de déterminer l'épidémiologie des brûlures dans la ville de Zanjan, dans le nord-est iranien. Les dossiers de 2 590 patients hospitalisés entre décembre 2010 et décembre 2016 dans le CTB de Zanjan ont été revus. Les données concernant l'âge, le sexe, la saison de survenue, la cause, la profondeur de la brûlure, la durée d'hospitalisation et le devenir du patient ont été relevées et analysées. Environ 65% (1 691) des patients étaient des hommes, l'âge moyen était de 25,4 ans. La majorité (92,8%) des brûlures touchaient moins de 30% de SCT. La durée de séjour moyenne était de 9,1 jours. Les causes les plus fréquentes étaient, par ordre décroissant, les liquides, les explosions de gaz et les feux. Il n'existait pas de relations entre les causes et les variables démographiques, mis à part les brûlures auto-infligées, plus « masculines ». La mortalité était de 2,9%, plus élevée en début de période d'étude. Les brûlures lors d'un incendie avaient tendance à devenir moins fréquentes alors que les brûlures chimiques le devenaient plus. La mortalité après brûlure par explosion de gaz ou chimique était en augmentation. Une partie des résultats observés pourrait être liée aux sanctions internationales à l'encontre de l'Iran. Le développement industriel iranien entraîne la nécessité de développer des mesures de prévention des brûlures chimiques, électriques et liées aux explosions de gaz.

Mots-clés: épidémiologie, brûlures, Iran, chimiques

Introduction

Burn injury is more common in socioeconomically poor societies and underdeveloped areas.¹ Epidemiological patterns of burns differ widely in different parts of the world.² Their prevention in a certain region must be based on etiological patterns as well as geographical and socioeconomic differences.³

Burn is the 8th cause of mortality and the 13th cause of morbidity in Iran.⁴ According to World Health Organization reports, 238,000 people died of fire burn in the world in 2000,

and 95% of them were in low- and average-income countries.⁵ Burn patterns and risks differ completely in low- and average-income countries.³

In the past decades, numerous articles about burns have been published, some of them in international journals and others in national or local ones. There are some studies on burn epidemiology in Iran, but the causes of burn are changing over time because Iran is a developing country. Thus, the literature lacks a clear, thorough image of burn epidemiology in Iran.³ Since preventive measures require a precise understanding of

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burn risk factors and epidemiology, we attempted to examine the epidemiology of burns in Zanjan city, Iran, by a systematic study of existing information. The goal was to identify burn factors and help in planning preventive strategies.

Method

In this cross-sectional research, the medical files of 2,590 burn patients who had been treated in our hospital in Zanjan city, in northwest Iran, from December 2010 to November 2016 were studied. The inclusion criteria included all patients suffering from 2nd and 3rd degree thermal burns. Patients who were treated in the emergency room (out-patient clinic) and were released without medical records were excluded from this research. Patient information, including age, sex, total body surface area (TBSA), season, burn cause, hospital stay and treatment results (whether they healed or died in the hospital) were analyzed. Burned TBSA was classified into four groups: less than 30%, 30% to 50%, 51% to 70% and over 70%.

Data were analyzed with statistical package for social sciences (SPSS) version 16 (Chicago, IL, USA). Qualitative data was presented in the form of number and percentage, and quantitative data in the form of mean, median and standard deviation. The relationships between sex, age, TBSA, cause of burn, hospital stay and mortality rate were investigated using the chi-square and independent t tests, and analysis of variance. Multivariate logistic regression analysis was used to study the modified effect of age, sex, TBSA and hospital stay on mortality. P value less than 0.05 was considered significant.

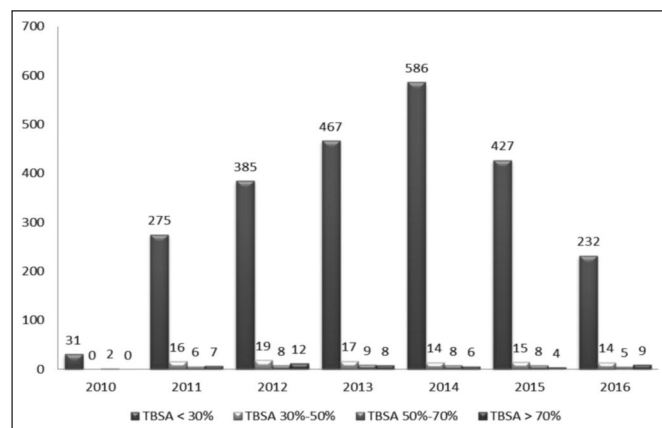


Fig. 1 - The trend of burns in our center from 2010 to 2016 based on burned TBSA in each year.

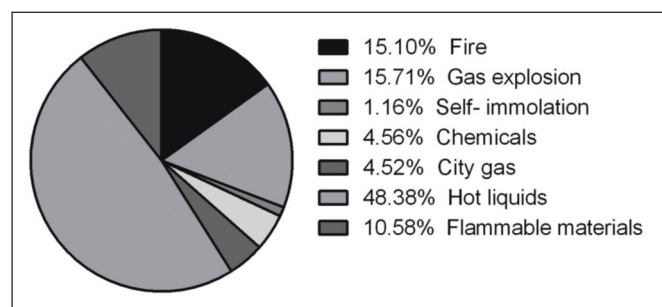


Fig. 2 - Burn causes in our studied patients in a hospital in Zanjan city from 2010 to 2016.

Results

About 65% of the patients were male (n=1691) and most had less than 30% burned TBSA (Fig. 1). Mean age and hospital stay were 25.4 years old and 9.1 days, respectively (Table I). The most common causes of burn were hot liquids, gas explosion and fire, respectively (Fig. 2). Except for self-immolation, which was more common among men, there was no significant relationship between cause of burn and the studied variables. About 32% of our burned patients were 10 years old or younger (n=830). Most of the patients (36.6%) were in the 21-40 year-old age group (n=947) and the least (6.3%) were in the over 60-year-old age group (n=162) (Fig. 3, Table II). In addition, the prevalence of gas and chemical burns increased and the prevalence of fire burns decreased in the studied period.

Burned TBSA was not significantly related to sex and age.

Table I - Patient information

Study variables		Number (%)
Sex	Female	899 (34.7)
	Male	1691 (65.3)
Burned surface	< 30%	2403 (92.8)
	30%- 50%	95 (3.7)
	51%-70%	46 (1.8)
	> 70%	46 (1.8)
Season	Spring	642 (24.8)
	Summer	701 (27.1)
	Autumn	568 (22)
	Winter	673 (26)
Mortality	No	2516 (97.1)
	Yes	74 (2.9)
Age (years old)	Mean	Median (Min-Max)
	25.4	25 (1-94)
Hospital stay (days)		Standard Deviation
		20.5
Summary of this table: more males than females; most burns are less than 30%; very few > 70%; no significant seasonal variation; low overall mortality; overall short hospital stay reflecting low number of serious burns		11.9

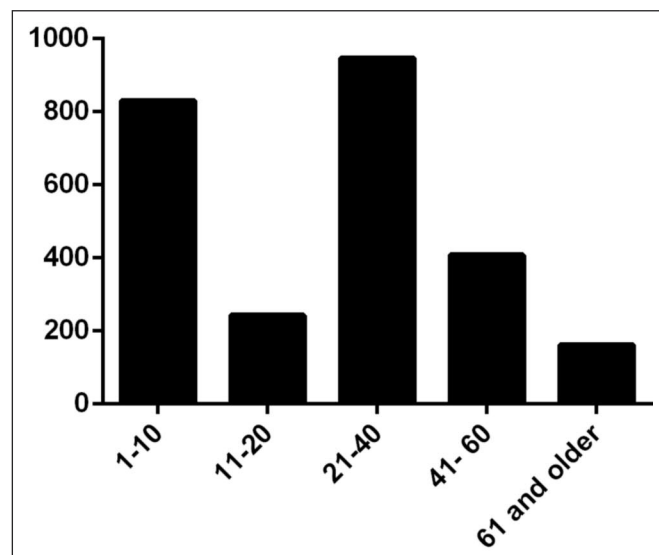


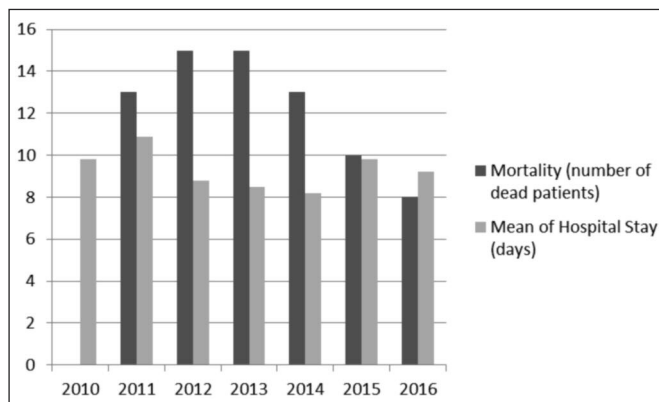
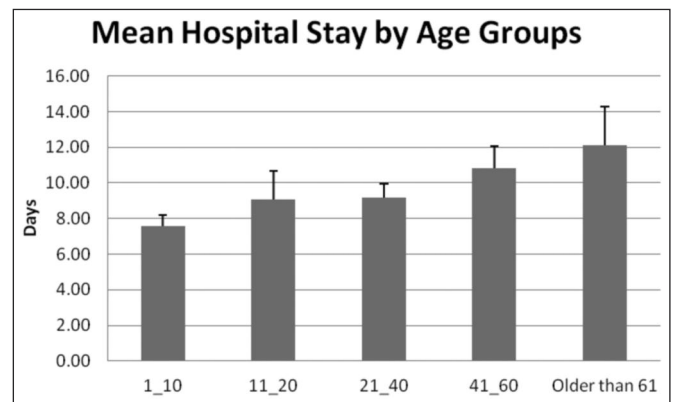
Fig. 3 - The total number of burned patients in each age group from 2010 to 2016.

Table II - Results of the studied variables based on etiology in a hospital in Zanjan city from 2010 to 2016

Cause		Fire	Gas explosion	Car explosion	Chemicals	City gas	Hot Liquids	Flammable materials	P value
Study variables									
Sex Number (%)	Female	132 (14.7)	160 (17.8)	6 (0.7)	35 (3.9)	46 (5.1)	408 (45.4)	112 (12.5)	0.012
	Male	259 (15.3)	247 (14.6)	24 (1.4)	83 (4.9)	71 (4.2)	845 (50)	162 (9.6)	
	Total	391 (15.1)	407 (15.7)	30 (1.2)	118 (4.6)	117 (4.5)	1253 (48.4)	274 (10.5)	
Burned surface Number (%)	< 30%	352 (90.0)	380 (93.4)	28 (93.4)	109 (92.5)	109 (93.2)	1164 (92.9)	261 (95.2)	0.237
	30%- 50%	17 (4.3)	17 (4.2)	1 (3.3)	3 (2.5)	5 (4.3)	47 (3.7)	5 (1.8)	
	51%-70%	16 (4.2)	5 (1.2)	0 (0)	3 (2.5)	1 (0.8)	17 (1.4)	4 (1.5)	
	> 70%	6 (1.5)	5 (1.2)	1 (3.3)	3 (2.5)	2 (1.7)	25 (2)	4 (1.5)	
Mortality Number (%)	No	374 (95.7)	395 (97.1)	29 (96.7)	114 (96.6)	113 (96.6)	1223 (97.6)	268 (97.8)	0.566
	Yes	17 (4.3)	12 (2.9)	1 (3.3)	4 (3.4)	4 (3.4)	30 (2.4)	6 (2.2)	
Age group (years old) Number (%)	1-10	143 (17.2)	121 (14.6)	7 (0.8)	34 (4.1)	45 (5.4)	393 (47.3)	87 (10.5)	0.401
	11-20	30 (12.3)	46 (18.9)	2 (0.8)	8 (3.3)	9 (3.7)	126 (51.9)	22 (9.1)	
	21-40	126 (13.3)	149 (15.7)	12 (1.3)	51 (5.4)	34 (3.6)	474 (50.1)	101 (10.7)	
	41- 60	61 (15)	66 (16.2)	5 (1.2)	17 (4.2)	23 (5.6)	192 (47.1)	44 (10.8)	
	Older than 61	31 (19.1)	25 (15.4)	4 (2.5)	8 (4.9)	6 (3.7)	68 (42)	20 (12.3)	
Hospital stay (days)	Mean	9	9.2	8.3	8.6	8.5	9.2	9	0.993
	Median (Min-Max)	5 (1-116)	5 (1-99)	4.5 (1-39)	5 (1-57)	5 (1-63)	5 (1-99)	5 (1-99)	
	Standard Deviation	12	12.1	9.8	11.3	10.7	11.7	13	
Summary of this table: most burns are due to hot liquids for both males and females; most burns were < 30% regardless of etiology; mortality is almost the same regardless of etiology, most common etiology was scald burns for all age groups									

Table III - Results of the studied variables based on burned total body surface area in a hospital in Zanjan city from 2010 to 2016

Burned Surface		< 30%	30%-50%	51%-70%	> 70%	P value
Variables						
Sex Number (%)	Female	836 (34.8)	38 (40)	10 (21.7)	15 (32.6)	0.196
	Male	1567 (65.2)	57 (60)	36 (78.3)	31 (67.4)	
Mortality Number (%)	No	2388 (99.4)	82 (86.3)	27 (58.7)	19 (41.3)	<0.001
	Yes	15 (0.6)	13 (13.7)	19 (41.3)	27 (58.7)	
Age group (years old) Number (%)	1-10	801 (96.5)	20 (2.4)	6 (0.7)	3 (0.4)	0.004*
	11-20	204 (84)	11 (4.5)	12 (4.9)	16 (6.6)	
	21-40	870 (91.9)	37 (3.9)	19 (2)	21 (2.2)	
	41- 60	379 (92.9)	19 (4.7)	7 (1.7)	3 (0.7)	
	Older than 61	149 (92)	8 (4.9)	2 (1.2)	3 (1.9)	
Hospital stay (days)	Mean	8.4	19.7	27.1	9.9	<0.001
	Median (Min-Max)	5 (1-96)	16 (1-116)	23.5 (1-77)	6 (1-62)	
	Standard Deviation	11	17.6	14.8	13.4	
* Fisher’s exact test p value						

**Fig. 4** - The trend of burns in our center from 2010 to 2016 based on mortality and mean hospital stay in each year.**Fig. 5** - Distribution of hospital stay based on age groups.

However, an increase in burned TBSA led to an increase in hospital stay and mortality (*Fig. 4, Table III*). Mortality increases sharply in TBSA >50%. Age and hospital stay of de-

ceased patients was significantly higher than that of survivors (*Fig. 5; P < 0.001*). In addition, the average age of patients and hospital stay changed over the studied six-year period. How-

Table IV - Results of the studied variables based on admission year in a hospital in Zanjan city from 2010 to 2016

Study Year		2010	2011	2012	2013	2014	2015	2016	P value
Variables	Female	8 (24.2)	110 (36.2)	158 (37.3)	177 (35.3)	200 (32.6)	171 (37.7)	75 (28.8)	0.120
	Male	25 (75.8)	194 (63.8)	266 (62.7)	324 (64.7)	414 (67.4)	283 (62.3)	185 (71.2)	
	Total	33	304	424	501	614	454	260	
Burned surface Number (%)	< 30%	31 (93.9)	275 (90.5)	385 (90.8)	467 (93.2)	586 (95.4)	427 (94.1)	232 (89.2)	0.071
	30%-50%	0 (0)	16 (5.3)	19 (4.5)	17 (3.4)	14 (2.3)	15 (3.3)	14 (5.4)	
	51%-70%	2 (6.1)	6 (2)	8 (1.9)	9 (1.8)	8 (1.38)	8 (1.8)	5 (1.9)	
	> 70%	0 (0)	7 (2.3)	12 (2.8)	8 (1.6)	6 (1)	4 (0.9)	9 (3.5)	
Mortality Number (%)	No	33 (100)	291 (95.7)	409 (96.5)	486 (97)	601 (97.9)	444 (97.8)	252 (96.9)	0.437
	Yes	0 (0)	13 (4.3)	15 (3.5)	15 (3)	13 (2.1)	10 (2.2)	8 (3.1)	
Age group (years old) Number (%)	1-10	11 (33.3)	71 (23.4)	114 (26.9)	191 (38.1)	208 (33.9)	155 (34.1)	80 (30.8)	0.006
	11-20	3 (9.1)	40 (13.2)	40 (9.4)	46 (9.2)	51 (8.3)	35 (7.7)	28 (10.8)	
	21-40	12 (36.4)	122 (40.1)	176 (41.5)	164 (32.7)	240 (39.1)	144 (31.7)	89 (34.2)	
	41- 60	5 (15.2)	50 (16.4)	66 (15.6)	70 (14)	85 (13.8)	88 (19.4)	44 (16.9)	
	Older than 61	2 (6.1)	21 (6.9)	28 (6.6)	30 (6)	30 (4.9)	32 (7)	19 (7.3)	
Hospital stay (days)	Mean	9.8	10.9	8.8	8.5	8.2	9.8	9.2	0.030
	Median (Min-Max)	4 (1-62)	7 (1-99)	5 (1-77)	4 (1-99)	4 (1-99)	6 (1-116)	6 (1-74)	
	Standard Deviation	14.4	14.7	11.4	11.7	10.96	11.8	10.9	

Table V - Results of multivariate logistic regression for analyzing the relationship of age, gender, burn degree, and hospital stay with mortality in our patients from 2010 to 2016

Study variables	P value	Odds ratio	95% confidence interval for odds ratio	
			Lower	Upper
Sex (male)	.011	2.2	1.2	4.2
Age (years old)	<0.001	1.03	1.02	1.05
Burned surface < 30%		1	Reference group	
Burned surface 30-50%	<0.001	18	7.9	41
Burned surface 51-70%	<0.001	135.7	57.2	322.1
Burned surface > 70%	<0.001	333.6	141.1	788.6
Hospital stay (days)	.007	1.02	1.01	1.04

ever, the changes were not significant. The number of burned patients was the highest in 2013 (n=501) and 2014 (n=614) (Table IV).

The likelihood of death increased 1.03 times with a one-year increase in the age of the studied population. In addition, women's mortality was 2.2 times higher than men's. With a one-day increase in hospital stay, the likelihood of death increased 1.02 times and with a one-degree increase in burned TBSA, mortality increased considerably (Table V).

Discussion

Most of the patients included in our study had less than 30% burned TBSA. Various studies have reported an incidence of 1.5% to 65%.³ Kai-Yang and colleagues have mentioned more than 30% burned TBSA as an important predictor of poor treatment outcome and death.⁶

Extent of TBSA burned was not significantly related to age and sex. Although the number of burned males was higher than females in each TBSA category, burn prevalence was greater in the under 10 and 21-40 year-old age groups. Most cases of TBSA over 30% had happened in 21-40 year-old patients. Mortality was 0.6% in TBSA less than 30%, but 58.7% in TBSA over 70% (Table III).

Our patients' age range was from 1 to 94 years old, with a mean age of 25.4 years. Mean ages were 19 to 35 years in some studies.⁷⁻¹³ Unlike in many European countries, Iran's population is young. So burns are more likely to happen in younger people; burns have not been prevalent among the elderly in recent decades. In three other studies in Iran, the mean ages of burned patients were 27.5 to 31 years old.⁷⁻⁹ Still, given the weaker prognosis of burns in the elderly, they are in need of special attention. Fortunately, overall prevalence, intensity, hospital stay and mortality associated with burns have decreased, especially in developed countries.¹

Similar to our results, the prevalence of all burn types has been higher among men in many studies^{3,14-17} but women's mortality was 2.2 times higher than men's. However, in a study conducted in the north of India, the prevalence of burns was higher among women.²

Self-immolation occurs at younger ages in Iran. In a study in west Iran, the average age of self-immolation was 24.9 years old,¹⁰ but in other studies in southwest and central Iran the average age ranges were 15-24 years^{11,12} and 20-29 years,¹³ respectively. Mehrpour and colleagues also reported an average age range of 14-38 years¹⁸ for east Iran. In our research, self-immolation occurred at an older age (mean of 31.5 years old) mostly because of economic problems and was more prevalent in men. However, in research conducted in Iran and most other countries, self-immolation was more prevalent among women.³ This difference can be attributed to economic problems in our society due to the 10-year economic sanctions that had a serious impact on Iran's economy and people. Still, in another study from Iran the highest self-immolation prevalence was observed for the 16 to 25 year-old age range, and 76% of the burned patients were women.¹⁹ But in this specific period self-immolation was greater for the men in our city.

In some parts of Iran such as the East Azerbaijan province (located in northwest Iran), the prevalence of chemical burns is 10 times more in men than in women, and this is because of their high-risk jobs.²⁰ In our study prevalence of chemical burns in men was double that of women.

Mean hospital stay was 9.1 days in our research with no significant difference for different burn types. As TBSA in-

creased from 30% to 70%, this duration increased. But hospital stay decreased at more than 70% burned TBSA. The reason might be that since most patients with TBSA >70% die soon, their hospital stay will be shorter (*Table IV*). In a study in Taiwan, the average hospital stay was 18 days,¹⁶ which was due to the difference in the quality of treatment and care methods and patient release measures.

In some studies hot liquids were the most common cause of burns.^{16,21-24} However, in others the burns were mainly caused by fire.²⁵⁻²⁸ In our research, the most common causes of burns were hot liquids (48.4%), gas explosion (15.7%) and fire (15.1%). The most common cause of burn among children was hot liquids in many studies similar to ours^{3,23,24,28} (*Table II*). The prevalence of this type of burn decreases with an increase in age while fire burn increases.^{16,29} Based on Dissanaïke and Rahimi's study, burn is mainly caused by hot water in children while it is mainly caused by electricity or fire in young adults.³⁰ These differences can be attributed to the methodology of studies as well as cultural, geographical, economic and lifestyle differences between the study populations. In our research, fire burn decreased and burning due to gas explosion and chemicals increased over time from 2010 to 2016. This was probably because of the industrialization process in Zanjan province.

Mortality due to burns varies by region in Iran.³ The lowest mortality is caused by electrical and chemical burns.^{7,9,20} The reason may be that many types of severe electrical burns lead to death on site and patients are sent directly to the Forensics Department, not the hospital. Mortality caused by self-immolation reached 75% in some studies.^{11,26,31,32}

In patients with burned TBSA more than 30%, temporary biological dressing and early excision and graft are better treatments to decrease morbidity and mortality. Between 2002 and 2006, Hosseini and colleagues studied 118 burnt patients with 30-75% TBSA in Zanjan city, Iran. One of their study groups received the conventional treatment (n=53) and the other (n=65) received biological dressing (Xenoderm) treatment. The mortality rates of conventional and biological treatment groups were 19 (35%) and 7 (10.8%), respectively.³³

The overall mortality rate we reported during the study period remained almost constant and varied between 2.3% and 4.1%. We did not record any mortality in 2010 at the start of the study, but that year only 33 patients were included in the study. Two patients had 50-70% burned TBSA, but they did not die. This low overall mortality rate does not reflect the status of burn care in our center since most patients included in

the study were young and had less severe burns. Mortality rates of patients with TBSA 51-70% and > 70% were 41.3% and 58.7% from 2011 to 2016, respectively.

This high mortality may be explained by the limited resources available for treating seriously injured burn patients in our setting. As of 2010, sanctions imposed on Iran resulted in a severe shortage of drugs including antibiotics such as cefepime and tazocin (piperacillin and tazobactam). According to a recent statement in May 2017 by an Iranian official, there was a shortage of 600 drugs because of sanctions from 2011 to 2013. Today, this number has decreased to less than 30 drugs.³⁴ According to Iran's Minister of Health in June 2016, about 300 of the drugs lacking in that period were ones that were imported,³⁵ of which 73 drugs were banned by the United States.³⁶ Others were produced inside Iran but their raw materials were hard-to-import or banned.

These sanctions lead to less than optimal treatment of many cases.³⁷ The economic problems in society and families resulted in more self-immolations and death of some patients with severe burns. Although they were not numerous, they had a considerable effect on mortality percentages. Burn prevalence in our studied city reached its peak in 2013 and 2014 right before the negotiations that lead to the Joint Comprehensive Plan of Action in 2015 and subsequent lifting of sanctions.

Conclusion

The causes of burn have changed from 2010 to 2016 in Zanjan city, northwest Iran. Chemical and gas explosion burns have become more prevalent than before. Self-immolation has become more common among men and mortality has increased. Some of these findings were due to the economic and pharmaceutical sanctions on Iran. Because of Iran's industrial development, it is recommended that preventive measures be conducted for chemical, gas and electrical burns.

To prevent severe burns in our region, there should be a healthcare system in every company and organization; workers should be trained about burn materials before employment; all buildings should have an automatic fire alarm and fire extinguishers should be placed on every floor of every building. Mothers should be educated during pregnancy and their child's infancy on how to prevent pediatric burns. They need to know the most common causes of pediatric burns. Also, family psychology consultations must become more common to prevent unfortunate events including burns.

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